EXPLORING THE EFFECT OF NON-IDEAL MIXING USING AN ADM1 BASED MODEL

Yohannis Mitiku Tobo[*,], Youri Amerlinck[*], Merle de Kreuk[**], Jules van Lier[**] and Ingmar Nopens[*]**

BIOMATH, Department of Mathematical Modelling, Statistics and Bioinformatics, Ghent University, Coupure Links 653, B-9000 Ghent, Belgium. ** Department of Water Management, Sanitary Engineering Section, Delft University of Technology, Stevinweg 1, 2628 CN Delft, The Netherlands.

Corresponding author: *YohannisMitiku.Tobo@UGent.be*

Objective: Modelling anaerobic digester (AD) for different configurations and scenarios to study the effects of the non ideal mixing.

Methodology:

- Modelling full scale AD using anaerobic digester model no. 1 (ADM1), implemented in WEST. .
- Three steady state modelling cases are considered: completely stirred-tank reactor (CSTR), two tanks in series (TTIS) case 1 and case 2 (two phase digester).
- Modelling full scale digester without recirculation of the overflow sludge. Full scale digester is mechanically agitated, assumed completely mixed and has a volume of 9000m^3.

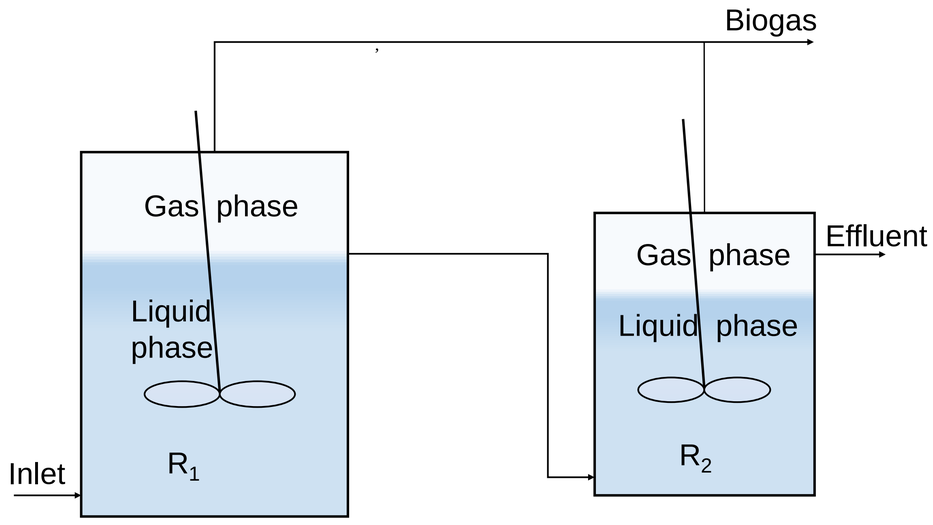

Figure 1: TTIS configuration

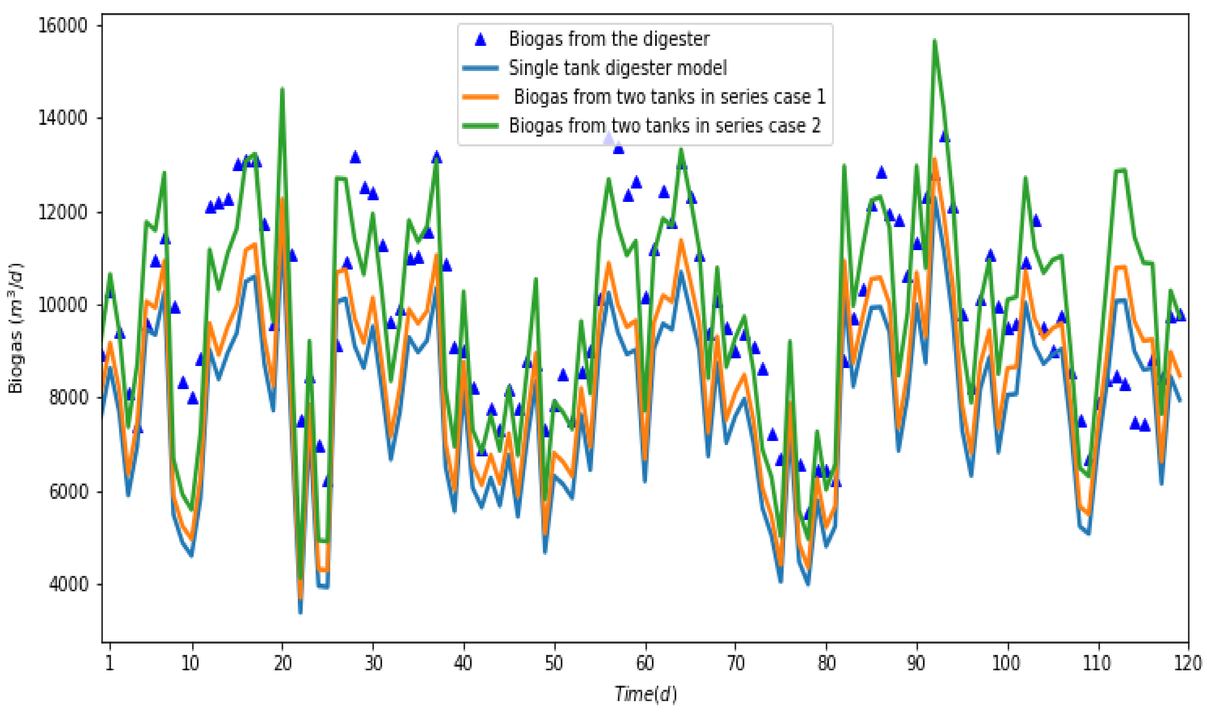

Figure 2: Biogas flow rate

- ✓ Total biogas flow rate for TTIS (case 2) fits well to full scale measurements (figure 2) while TTIS case 1 and CSTR fit significantly less, smaller volume better mixing.
- ✓ Computed methane concentration for the three cases are similar (figure 3: b,c and d) and higher than measured methane concentration by 8%.

Conclusion

- Computed results from figure 2 and 3 shows TTIS produces more biogas and methane concentration respectively than a CSTR due to:
  - enhanced complete mixing at lower reactor volumes and,
  - physical separation anaerobic digestion process, which enhances growth of biomass and uptake of substrate

Future work

- Details of hydrodynamics and bio-kinetic CFD modeling will be performed in near future and will provide more understanding of the bio-kinetic transformations and will identify which configuration and operating scenarios are more efficient.

Results

- ✓ TTIS case 1 produces more biogas when volume of R_1>R_2; an increased volume of R_1 results in increased solids retention time (SRT), preventing biomass loss from R_1.
- ✓ TTIS case 2: volume of R_1<< R_2 , in R_1 only hydrolysis and fermentation takes place at less SRT/HRT and R_2 operates for long SRT.
- ✓ Soluble ammonia inhibits uptake of acetate in all cases.
- ✓ Computed average pH is less than full scale measurement except in the second digester of case 2.
- ✓ TTIS produces 8% biogas when compared to CSTR.

Figure 3: Biogas composition

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